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CATARACT CREEK DAM

Manual for Operation and Maintenance

State Water Projects Bureau
Water Resources Division
Department of Natural Resources and Conservation
1520 East Sixth Avenue
P. O. Box 202301
Helena, MT 59620-2301

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OVERVIEW

Cataract Creek Dam is located in Madison County, about 2 miles southwest (upstream) from the community of Pony and 8 miles southwest of the town of Harrison. (Figure 1) The reservoir is fed by Cataract Creek (Figure 2), which originates 2.3 miles southwest of Cataract Creek Dam at Mason Lake. The Cataract Creek Water Users Association (herein referred to as "association") operates the dam.

The earthfill dam was completed in 1959. Cataract Creek Dam is 80 feet high and 775 feet long. The dam's outlet works consist of a 4.83-foot diameter dry well with two 30-inch diameter gate valves. The upstream valve is used for emergency shutoff, while the downstream valve is the operating valve. The operating valve is operated by a handle located at the top of the tower. The emergency valve is operated by a hand wheel located at the bottom of the tower. The maximum capacity of the outlet works is 160 cubic feet per second (cfs). The spillway is located in the right abutment and consists of an earthen channel, a concrete drop structure and an earthen exit channel. The drop structure has a bottom width of 20 feet. The maximum capacity of the spillway is 1,250 cfs. The reservoir has a normal capacity of 1,478 acre-feet at the spillway crest and a maximum capacity at the dam crest of 1,800 acre-feet.

Water from the reservoir is delivered to association members via Cataract Creek and North Willow Creek to their diversions on North Willow Creek. Water from the reservoir is primarily used for irrigation water supply. The reservoir also is used for water-based recreation.

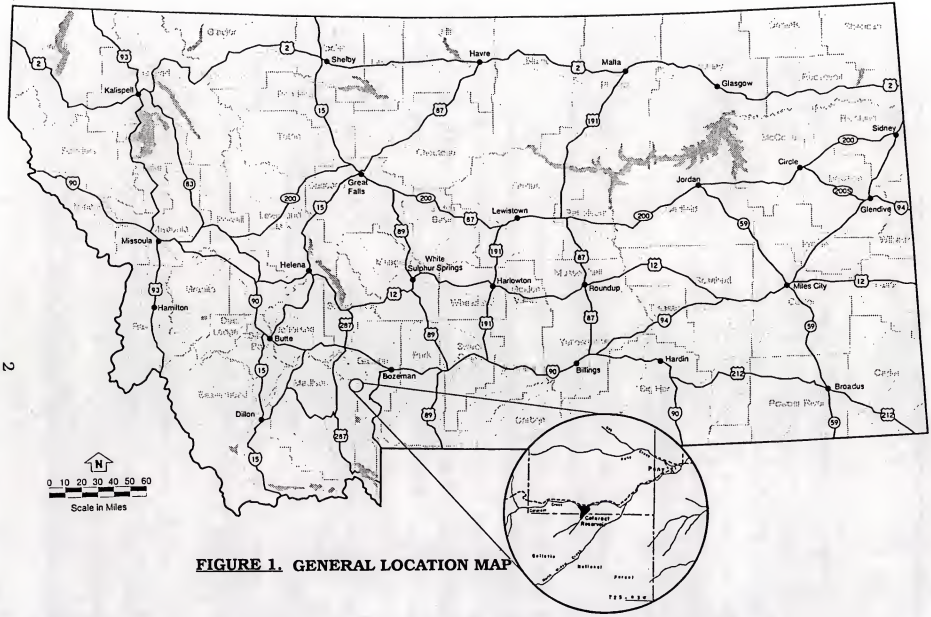


FIGURE 1. GENERAL LOCATION MAP

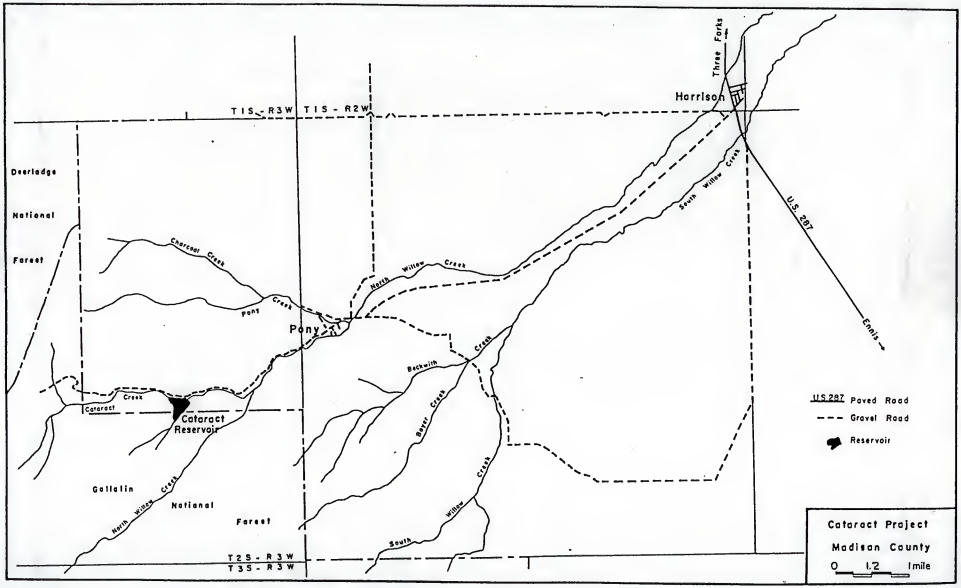


FIGURE 2. PROJECT AREA MAP

STATISTICAL INFORMATION

1. General

a)	Owner	Montana Department of Natural Resources and Conservation (DNRC)
b)	Operator	Cataract Creek Water Users Association
c)	Location	Section 23, Township 2 South, Range 3 West (dam location)
d)	Latitude Longitude	45° 38' 36" 111° 56' 12"
e)	County--State	Madison--Montana
f)	Watershed Location	Cataract Creek, from Mason Lake; tributary of North Willow Creek
g)	Drainage Area	6.1 square miles

2. Principal Elevations (feet above mean sea level)

a)	Maximum Dam Crest	6,360.0 feet
b)	Normal Full Pool	6,353.0 feet
c)	Toe of Dam	6,280.0 feet

3. Reservoir

a)	Length of Maximum Pool (approximate)	0.36 miles
b)	Surface Area at Normal Pool	45 acres

4. Storage

a)	Maximum Storage (elevation 6,360.0 feet)	1,800 acre-feet
b)	Active Storage (elevation 6,353.0 feet)	1,478 acre-feet
c)	Maximum Surcharge	322 acre-feet

5. Hydrology

a)	Probable Maximum Flood (PMF)	10,200 cfs (8,450 acre-feet)
b)	500-yr Return Period Flood	225 cfs
c)	100-yr Return Period Flood	160 cfs

6. Embankment

a)	Type	Earthfill
b)	Hydraulic Height	80 feet
c)	Crest Length	775 feet
d)	Crest Width	20 feet
e)	Downstream Slope	1v on 2.0h
f)	Upstream Slope	1v on 3.0h

7. Outlet Works

a)	Size	30-inch, horseshoe-shaped, reinforced concrete
b)	Length	390 feet

c)	Control	Two 30-inch diameter gate valves in series. The upstream valve is operated from the bottom of a 4.83-foot diameter dry well. The downstream valve is operated from the top of the tower.
d)	Capacity (at elevation 6,360.0 feet)	160 cfs
e)	Invert Elevation	6,293.0 feet (from drawings)
f)	Trashrack	Yes

8. Spillway

a)	Location	Right abutment
b)	Type	Uncontrolled, unlined, open channel with a concrete drop structure
c)	Width (bottom)	20 feet
d)	Length	720 feet
e)	Capacity (at elevation 6,360.0 feet)	1,250 cfs

OPERATING PROCEDURES

The association manages Cataract Creek Reservoir to provide an adequate supply of irrigation water to meet contracts with water users without exceeding safe storage and flow levels.

Method and Schedule of Operation

Water stored in the reservoir supplements the flow of North Willow Creek during the irrigation season. The association strives to impound the maximum amount of water below the spillway crest prior to the irrigation season. The reservoir level has reached the spillway crest only twice and generally peaks in late-May or June. Water from the reservoir supplements irrigation flows for a month or more after the reservoir reaches its highest level. Naturally, the actual dates vary depending on each year's climatological and hydrological conditions.

Water from Cataract Creek Reservoir is commonly discharged via the seep (see "Seepage Monitoring" section). The timing of these "natural" releases generally suits the needs of the contract holders. Typically the dam operator uses the outlet works to allow stored water from Mason Lake to pass through Cataract Dam.

The maximum reservoir elevation for winter storage is 6,345.0 feet with 1,139 acre-feet of storage. This winter maximum helps prevent damage to the riprap and embankment from wind-driven waves and ice. The minimum reservoir elevation for winter storage is 6,295.0 feet with

6 acre-feet of storage. This winter minimum helps prevent ice damage to the inlet structure for the outlet works.

Safe Drawdown

Because the stability of Cataract Creek Dam has not been thoroughly investigated, DNRC recommends that drawdown rates not exceed one foot per day.

Limitations of Appurtenances

The appurtenances at Cataract Creek Dam are the outlet works and the spillway. The capacity of the outlet works is 160 cfs at the maximum dam crest elevation. The maximum opening is 30 inches for both gates. This is measured from the top of the gate stem to the top of the pedestal. In addition, the spillway will discharge 1,250 cfs when the reservoir water is at the dam crest. A rating table for the spillway is in Appendix A.

Dam Operator

The association has not hired a dam operator. In this manual, the term "dam operator" refers to the court-appointed water commissioner for North Willow Creek.

The association and the dam operator are responsible for the daily operation of the dam and reservoir. While the dam operator performs summer operations of Cataract Creek Dam, all of the members of the association operate the dam during the rest of the year, .

The dam operator is generally authorized to operate the reservoir to meet the court's admeasurement of water and the association's goals of supplying water while maintaining safe storage and flow levels. The dam operator's specific responsibilities are to:

1. *Admeasure water as directed by the court.*
2. *Operate the mechanical features of the outlet works.*
3. *Coordinate filling the reservoir and releasing water.*
4. *Notify the State Water Projects Bureau (SWPB) of unusual occurrences* such as impending floods, excessive seepage, etc.
5. *Notify the association of the need for certain routine maintenance tasks.*
6. *Monitor weather conditions.*
7. *Monitor seepage.*

Typically, the out-going dam operator and the association train a new dam operator. The dam operator's training focuses on the mechanical operation of the gates, storage level observation, measurement of the rate of water releases, and record keeping. The gates are operated manually with a hand crank or handwheel. The outlet works are intended to be used for controlling the release of irrigation water and not for providing emergency relief.

The dam operator is normally available daily to observe the dam, admeasure irrigation water, and perform operating functions during the

filling and irrigation season. A landowner adjacent to the dam is regularly on-site tending his stock and reports any problems to the association president who typically visits the dam monthly. While communication among the dam operator, the association, and the SWPB usually takes place by telephone, radio communication may be established during emergencies or unusual occurrences, so that the dam operator or the association can speak directly with county authorities and communicate indirectly with the SWPB (see *Cataract Creek Dam Emergency Action Plan*).

Weather Monitoring

The association and the dam operator monitor weather conditions through local weather forecasts and the National Weather Service.

Interaction With Other Dams

Except for irrigation diversion dams, Willow Creek Dam is the next dam downstream from Cataract Creek Dam. The safety of Willow Creek Dam is not affected by the normal operation of Cataract Creek Dam. During emergency operations, the association will notify the operator at Willow Creek Dam (Barry McLane **406-285-3689**) to observe the inflows into Willow Creek Reservoir and implement the *Willow Creek Dam Emergency Action Plan*, if necessary.

INSPECTION AND MONITORING

The SWPB will inspect the dam annually. Appendix B includes an example of a SWPB inspection checklist. In addition to annual inspections, SWPB personnel will inspect the dam and reservoir during and after heavy runoff, severe rainstorms, and severe windstorms; during high storage periods; and after an earthquake. The embankment is not monitored by instrumentation.

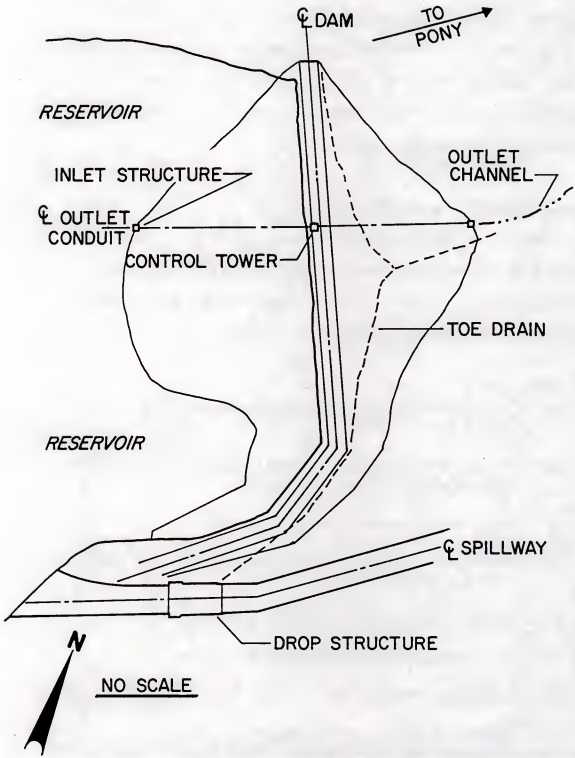
Structural Features Inspection

Structural features include the control tower, outlet works, and spillway drop structure (Figure 3). The SWPB will inspect these structures annually as part of its inspection program. Items to be checked or noted include, but are not limited to:

1. *Outlet Works*
   a) Any differential settlement or movement resulting in cracking of the conduit
   b) Erosion of the seals or concrete by cavitation immediately downstream of the gates
   c) Major seepage of water into the conduit
   d) Major deterioration of exposed concrete due to freeze/thaw cycles or sulfate reactions
   e) Operation of both gates through a full cycle
   f) Free, unobstructed operation of the air vent
   g) Corrosion of any metal
   h) Proper lubrication of the pedestals

FIGURE 3.

GENERAL LAYOUT



2. *Control Tower and Cover*
   a) Any damage or vandalism

3. *Spillway*
   a) Deterioration of concrete

   b) Separation or movement of joints

   c) Erosion of the spillway chute, backfill behind the walls, or stilling basin

   d) Blockage of the approach or exit channel

4. *Embankments*
   a) Erosion gullies in dam and dike faces.

   b) Damage from burrowing animals or vegetation.

   c) Displacement or loss of rip-rap protection.

   d) Displacement of fill, sink holes, slumps etc.

   e) Any seepage.

Riprap Inspection

The riprap along the faces of the dam should be at least 24 inches thick (the original placement depth). Immediately after the occurrence of high water, the riprap will be inspected and additional riprap added if needed.

Seepage Monitoring

No seeps are visible immediately below the dam. Seepage water flows in a wide, relatively flat reach of channel 500 to 1,000 feet

downstream from the dam. It is assumed that this flow is seepage from the dam, although its flow path is not well understood. The flow (quantity and turbidity) is monitored at a Parshall flume just downstream from the wet area. The flow is always clear, and no unexplained increases in flow have occurred. The measurements in the weir will be recorded by the dam operator and during the SWPB inspections.

These areas of seepage will be observed and monitored by the dam operator during regular visits and by the SWPB during annual inspections. To date, there has been no seepage monitoring equipment installed at the dam. The drain will be measured by a bucket and stopwatch when it is flowing.

MAINTENANCE

The association is responsible for the project's routine maintenance. During regular visits, the association will identify and perform normal maintenance activities. During the annual inspections, the SWPB will also identify items that need maintenance or repair. The SWPB may supervise major repairs.

Routine Maintenance

As soon as a need is identified, the association will perform any routine maintenance necessary to protect the dam or keep it in good working order. The dam operator and association members will watch for any potential maintenance requirements during normal visits to the dam. Items that may occasionally need attention include, but are not limited to:

1. *Lubrication of gate-operating mechanisms.*

2. *Debris or silt restricting the spillway inlet or the outlet works.* Accumulated debris that could affect the operation of these appurtenances will be removed at once, with all debris removed at least annually.

3. *Erosion gullies on embankment.* Development of erosion gullies will be checked immediately. Gullies will be filled, compacted, and seeded. Particular attention will be paid to the abutment contact areas and the downstream face where four-wheel-drive or motorcycle tracks may become a problem.

4. *Rodent damage.* Rodent burrows will be filled immediately and the rodents destroyed.

5. *Upstream slope riprap.* Reservoir riprap normally will be maintained annually, but may occasionally need repairs because of high water or wave action.

6. *Vegetative cover on downstream slope.* Good vegetative cover will be maintained, but large brush and trees will be removed from the downstream slope and the spillway channel.

Annual Maintenance

The SWPB will conduct annual inspections of Cataract Creek Dam and Reservoir. During these inspections, any items requiring maintenance will be identified and recorded. Items that need annual maintenance include the spillway, outlet works, gates, riprap, roads, and tower cover. Any other routine items that need immediate attention also will be noted.

After the association receives the SWPB inspection report, it will develop a maintenance schedule for the identified tasks. While association members may perform these routine tasks, major repairs are more likely to be handled by a contractor. The SWPB may assist in contracting for repairs and may supervise the repair work.

Record Keeping

The SWPB will maintain records--including photographs--of all inspections and maintenance requirements. These records will also include flow measurements and storage volumes. Anyone who wants to review these records may do so in the SWPB's office at the Department of Natural Resources and Conservation in Helena.

The dam operator will keep records of the reservoir elevation, seepage observations or measurements, and any unusual conditions. These records may be reviewed at the dam operator's house.

REFERENCES

CH2M Hill. April 1980. *Phase 1 Inspection Report, National Dam Safety Program, Cataract Creek Dam, Pony, Montana, Madison County, MT-5.* Prepared for the State of Montana (DNRC) under the U.S. Army Corps of Engineers' National Dam Safety Program.

Omang, R. J. July 1992. *Analysis of the Magnitude and Frequency of Floods and the Peak-Flow Gaging Network in Montana.* Water Resources Investigations Report 92-4048. U. S. Geological Survey.

Reich, George, President, Cataract Creek Water Users Association. December 1993 and March 1994. Personal telephone communication with Jim Beck, Regional Office Engineer, Mont. Water Resources Division DNRC, Helena.

APPENDIX A

RATING CURVES AND TABLES

TABLE A-1

RESERVOIR ELEVATION - STORAGE TABLE

Elevation *(feet)*	**Storage** *(acre-feet)*
6,280	0
6,285	0.2
6,290	1
6,295	6
6,300	29
6,305	73
6,310	137
6,315	226
6,320	336
6,325	466
6,330	612
6,335	772
6,340	947
6,345	1,139
6,350	1,347
6,355	1,478
6,360	1,800

FIGURE A-1

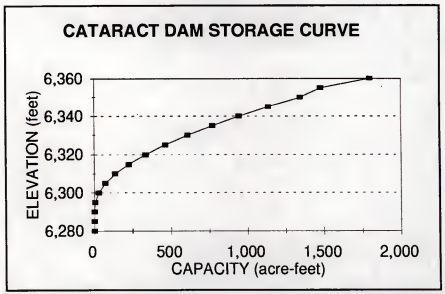
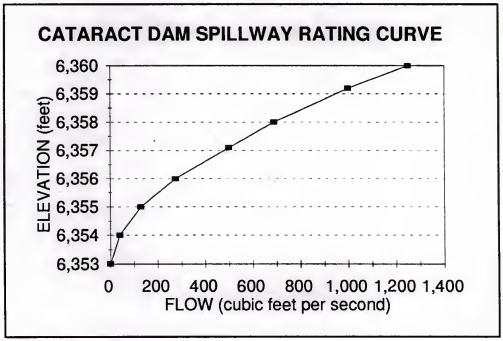


TABLE A-2

SPILLWAY RATING TABLE

Elevation *(feet)*	**Flow** *(cfs)*
6,353.0	0
6,354.0	40
6,355.0	130
6,356.0	275
6,357.1	500
6,358.0	690
6,359.2	1,000
6,360.0	1,250

FIGURE A-2



APPENDIX B

INSPECTION CHECKLIST

DEPARTMENT OF NATURAL RESOURCES AND CONSERVATION
DAM SAFETY INSPECTION REPORT

NAME OF DAM _____
DATE INSPECTED _____

INVENTORY NO. _____
HAZARD CATEGORY _____
TYPE OF DAM _____
YEAR BUILT _____

OWNER _____
OPERATOR _____
STREAM _____
DRAINAGE AREA _____

Reservoir Storage Status

	Water Surface Elevation (feet)	Storage (acre-feet)
At time of inspection	_____	_____
At spillway crest	_____	_____
At min. dam crest elevation	_____	_____
Flashboard crest elevation	_____	_____

ITEM	YES	NO	REMARKS	*ICC
1. **EMBANKMENT**				
A. Crest – Height= Length= Width=				
(1) Any visual settlements?				3
(2) Any misalignments?				4
(3) Any cracking?				1
(4) Any traffic damage?				5
(5) Other?				7

NOTE: *ICC stands for "Inventory Comment Code" which is found on the Inventory of Montana Dams. This comment code is for use by the Dam Safety Section.

ITEM	YES	NO	REMARKS	*ICC

1. EMBANKMENT (continued)

B. Upstream Face -- Slope=

(1) Any erosion?				19
(2) Any longitudinal cracks?				9
(3) Any transverse cracks?				9
(4) Is riprap protection adequate?				10
(5) Any stone deterioration?				19
(6) Any visual settlement, slumps, sloughing, depressions or bulges?				9
(7) Adequate grass cover?				14
(8) Debris on the dam face?				15
(9) Other?				16

C. Downstream Face--Slope=

(1) Any erosion?				22
(2) Any longitudinal cracks?				19
(3) Any transverse cracks?				19
(4) Any visual settlement, sloughing, slumps, depressions or bulges?				19
(5) Is the toe drain dry?				31
(6) Are the relief wells flowing?				31
(7) Any boils at the toe?				19
(8) Any seepage areas?				17, 18
(9) Any traffic or animal damage?				22
(10) Any burrowing animals?				21
(11) Adequate grass cover?				21
(12) Other?				25

D. Amount and Type of Vegetation on the Dam

	14, 24

ITEM	YES	NO	REMARKS	*ICC
2. ABUTMENT CONTACTS				
(A) Any erosion?				12, 20
(B) Any visual differential movement?				12, 20
(C) Any cracks?				12, 20
(D) Any seepage present?				36
(E) Other?				16, 25
3. OUTLET WORKS				
A. Intake Structure -- Size=				
(1) Any settlement?				70
(2) Any tilting?				70
(3) Do concrete surfaces show:				
a. Spalling?				70
b. Cracking?				70
c. Erosion?				70
d. Exposed reinforcement?				70
(4) Do joints show:				
a. Displacement or offset?				70
b. Loss of joint material?				70
c. Leakage?				70
(5) Metal appurtenances:				
a. Any corrosion present?				70
b. Any breakage present?				70
(6) Trash rack?				71
a. Condition?				71
b. Anchor system secure?				71
(7) Other?				71

ITEM	YES	NO	REMARKS	*ICC

3. OUTLET WORKS (continued)

B. Conduit -- Type = Size =

(1) Do concrete surfaces show:				
a. Spalling?				76
b. Cracking?				76
c. Erosion?				76
d. Exposed reinforcement?				76
(2) Do joints show:				
a. Displacement or offset?				76
b. Loss of joint material?				76
c. Leakage?				76
(3) Is the conduit metal?				76
a. Any corrosion present?				76
b. Protective coatings adequate?				76
(4) Is the conduit misaligned?				76
(5) Any calcium deposits?				76
(6) Other?				76

C. Gates and Tower

(1) Gates:				73, 74
a. Size: Operating: Emergency: b. Type: Operating: Emergency:				
(2) Controls operational?				76
(3) Controls lubricated?				76
(4) Operational problems?				76
(5) Leakage around gates?				73, 74
(6) Condition of gate seals?				73, 74
(7) Any cavitation damage? If so, describe?				73, 74
(8) Describe air vent-size and condition.				73, 74

ITEM	YES	NO	REMARKS	*ICC

3. OUTLET WORKS

C. Gates and Tower (continued)

(9) Is there a jet pump?				62
a. Is it operational?				62
b. Leakage?				62
(10) Is the tower dry? ____ wet? ____				77
(11) Any seepage in the tower?				77
(12) Condition of the tower?				77
(13) Any safety problems?				77
(14) Ladder in good condition?				77
(15) Condition of the gate house?				81
(16) Emergency plan completed for the dam?				43
a. Posted in the gatehouse?				43
(17) Other?				82

D. Stilling Basin

(1) Do concrete surfaces show:				
a. Spalling?				62
b. Cracking?				62
c. Erosion?				62
d. Exposed reinforcement?				62
(2) Do joints show:				
a. Displacement or offset?				62
b. Loss of joint material?				62
c. Leakage?				62
(3) Do energy dissipators show:				
a. Signs of deterioration?				62
b. Are they covered with debris?				62
(4) Other?				63

ITEM	YES	NO	REMARKS	*ICC

3. OUTLET WORKS (continued)

E. Downstream Channel

(1) Is the channel:				
a. Eroding or backcutting?				38
b. Sloughing?				38
c. Obstructed?				40
(2) Is released water:				
a. Undercutting the outlet?				52, 62
b. Eroding the embankment?				52, 62
(3) Other?				56,63

4. **SPILLWAY**

A. Description

(1) Location?				N/A
(2) Type of Spillway?				N/A
(3) Size of Spillway?				N/A
(4) Spillway lining?				N/A
(5) Is there a weir?				61
(6) Is the spillway in good condition?				N/A
(7) Any drains?				N/A
a. Describe the condition of drains.				64

B. Does spillway show:

(1) Any cracking concrete?				57, 58
(2) Any spalling concrete?				57, 58
(3) Any exposed reinforcement in the concrete?				57, 58
(4) Any erosion?				52

ITEM	YES	NO	REMARKS	*ICC
4. B. Does spillway show: (continued)				
(5) Any slope sloughing?				51
(6) Any obstructions?				54
(7) Displacement or offset joints?				59
(8) Loss of joint material?				57, 58
(9) Leakage at the joints?				57, 58
(10) Other?				63
C. Do the energy dissipators show:				
(1) Signs of deterioration?				62
(2) Any cracking?				62
(3) Any spalling?				62
(4) Any exposed reinforcement?				62
(5) Are they covered with debris?				62
(6) Other?				64
D. Has release water:				
(1) Eroded the embankment?				52
(2) Undercut the outlet?				52
(3) Eroded the downstream channel?				52
(4) Other?				56
E. Emergency Spillway				
(1) Is there an emergency spillway?			(If YES, describe)	55

ITEM	YES	NO	REMARKS	*ICC

5. **RESERVOIR CONTROL**

(A) Recent upstream development?				47
(B) Recent downstream development?				42
(C) Slides in reservoir area?				44
(D) Change in reservoir operation?				48
(E) Large impoundment upstream?				49
(F) Any debris in the reservoir?				50
(G) Other?				50

6. **INSTRUMENTATION**

(A) List type(s) of instrumentation:				27-33
(B) In good condition?				27-33
(C) Read periodically?				27-33
(D) Is data available?				27-33
(E) Include all data gathered since last report.				

7. **DOWNSTREAM CONDITION**

A. Downstream Land Use.

	41

This dam was inspected by:

Additional comments and recommendations. (Use additional pages)